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TRANSLATION

ABOUT A CERTAIN METHOD OF RECORDING WEAK INFRARED RADIATION

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A description is given of a modulation radiometer in the near infrared region in which glowing phosphorus is used as the receiving element.

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If onto excited and naturally extinguishing phosphorus one directs a beam of long-wave (especially, infrared) rays, as is known [1], [2], in the case of many kinds of phosphorus there will be an increase in the brightness of the fluorescence (optical flare-up). In the case of some kinds of phosporus one notes the phenomen of optical fading under the influence of long-wave rays. The optical flare-up is brought about by the acceleration of the emission transitions; optical fading is connected with the phenomenon under the action of long-wave radiation of non-emission transitions of electrons into the normal state. Optical flare-up or fading is superimposed on the natural phosphorescence. There the optical flare-up can be observed in the pure form if the temperature of the phosphorus is lower than the temperature of the natural fluorescence ("frozen" state).

Both the flare-up and the fading kinds of phosporus at the present time are used as receivers of infrared radiation (phosphorography). Interest is afforded by the clarification of the possibilities of using for this purpose various kinds of phosphorus in connection with a photomultiplier and modern radio-physics apparatus intended for decreasing the effect of fluctuation on the sensitivity and precision of the measurements. In such equipment it is feasible to use the modification method [4]; this makes it possible with the correct choice of frequency to eliminate the effect of slow drifts in the apparatus, brought about, for example, by the fluctuation in the amplification

of the photomultiplier. Thus one is concerned with the modulation radiometer for recording (or measuring) of infrared radiation with phosphorus acting as the receiving element.

The principals of the scheme of the modulation radiometer are presented in Fig. 1. The infrared radiation I_1, which is to be recorded or measured, is modulated with the aid of an obturator, and then it goes onto the flare-up or fade-out phosphorus Φ. The glowing of the phosphorus in this case also turns out to be modulated. On reaching the cathode of the photomultiplier (FEU) the visible light I_2 produces on its output the phenomenon of an alternating signal, the amplitude of which is proportional to the intensity of the infrared radiation. The signal from the output of the photomultiplier is passed to the input of a narrow-band filter tuned to the frequency of the modulator. The recording or measuring of the infrared radiation is done in accordance with an instrument at the output of the filter. For making up the energy lost by the phosphorus in luminescence there is used an ultraviolet auxiliary illumination I_3. The ultraviolet radiation, partially dissipated by the phosphorus, practically does not reach the photocathode being absorbed by a glass filter, not shown in the drawing.

It is advantageous to select a rather high frequency of the modulation in the modulation measuring devices (around 20 to 25 cps and higher) so that the slow drifts in the apparatus do not lower the sensitivity [3]. Therefore in the modulation radiometer for the infrared radiation it is necessary to use low-inertia phosphorus. As was explained, of all the available kinds of phosphorus the

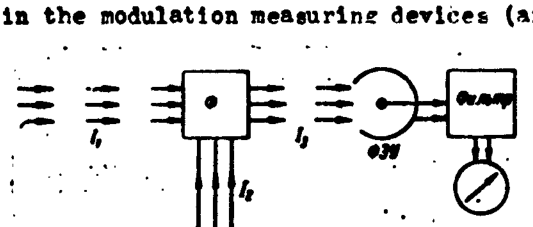

Fig. 1. Sketch showing principle of modulation radiometer with phosporus as receiver

most suitable type found proved to be SrS—Ce, Sm. This phosphorus also possesses other peculiarities which are favorable for its application in the modulation radiometer. In the case of a distinctly expressed phenomenon of optical scintillation the intensity of the natural phosphoresence of the phosphorus mentioned at room temperature is rather low. This determines a low value for the constant component of the current of the photomultiplier, and, consequently, also a low level of the electric fluctuations on its output*.

As a result of the little intensity the natural phosphorescence continues for a considerable interval of time (some hours). This does away with the need for constant "recharging" with the aid of ultraviolet rays.

The scheme of the experimental setup is shown in Fig. 2. As a source of infrared rays one uses an incandescent lamp L_1. The light from the source passes through the calibrated slit S_1 and is modulated with the aid of an obturator ($f = 23.75$ cps). Further on the light passes through the infrared filter F_1 separating out a spectral interval of from 1 to 3 microns. Outside of this interval the penetrability of the filter is practically zero. As experience has shown the photomultiplier FEU-19OM used in the unit is not sensitive to radiation passed through the filter F_1. The modulated infrared radiation falls on the phosphorus S and periodically produces an optical scintillation, which can be recorded by the photomultiplier. For exciting the phosphorus one uses ultraviolet radiation let out by the filter F_2 from the spectrum of a mercury lamp L_2 ($Л_2$). The ultraviolet rays fall on the phosphorus after reflection from an inclined glass plate P (П) which is

*The spectral density of the mean square of the fluctuations of the current on the output of the photomultiplier is proportional to the current constant component [5].

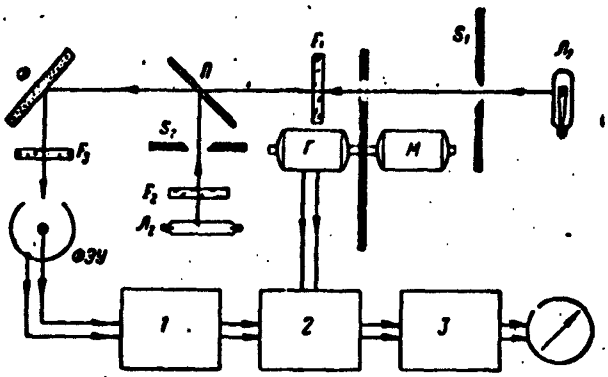

Fig. 2. Layout of experimental unit

transparent to infrared rays. To prevent the ultraviolet rays from falling on the photocathode there is a glass yello-green light filter F_3.

The voltage from the output of the photomultiplier is converted with the aid of a heterodyne filter, consisting of an amplifier 1, a balanced detector 2, and a filter of DC 3. The amplifier is designed on the resonance principle with the use of RC filters with negative feedback and tuned to the frequency of the modulator. The band passed through by the amplifier is equal to 1 cps. The coefficient of amplification on resonance frequency is of the order of 10^3. The reference voltage necessary for the operation of the balanced detector is taken from the generator G (Г) fixed on one shaft with the obturator. The band passed through by the filter of DC which determines the band of the whole heterodyne filter, and, consequently, also of the fluctuation limits for the sensitivity of the unit is equal to 0.1 cps.

Preliminary experiments conducted at room temperature of the phosphorus showed that the modulation radiometer possesses high sensitivity in the range of wave length from 1 to 3 microns, apparently exceeding the sensitivity of such receivers as the thermopyle and the bolometer in this range. This makes it possible to suppose that the radiometer with phosphorus as the receiver element can find use in some industrial applications.

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